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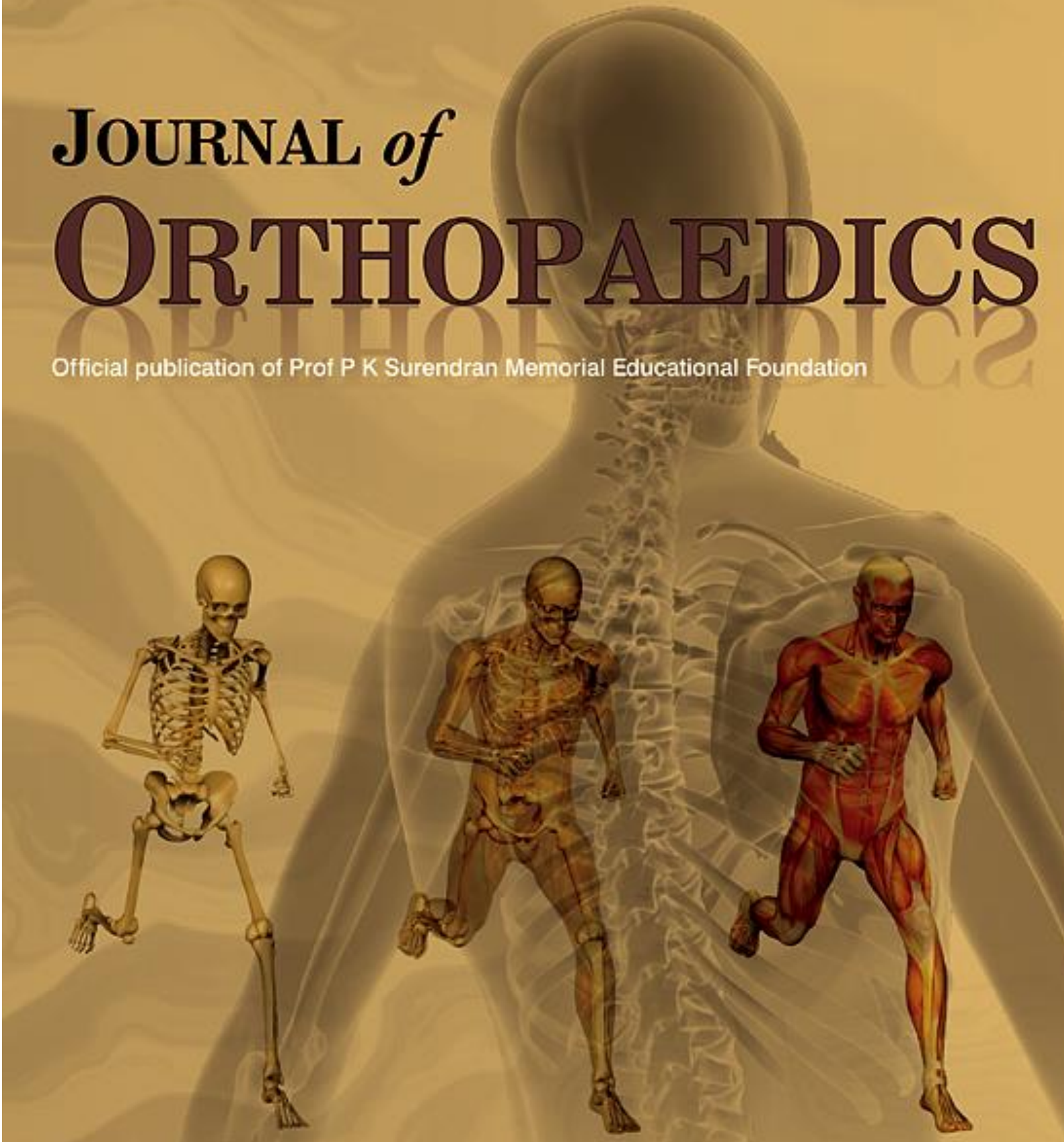

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# Proximal fibula osteotomy as an alternative to TKA and HTO in late-stage varus type of knee osteoarthritis

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ABSTRACT

*Background:* Knee osteoarthritis has a high prevalence in Indonesia. Aim of this research is knowing the outcome of knee osteoarthritis patient after PFO procedure.
*Methods:* Data collected and analyzed in hospitals in Surabaya from July to December 2017. This study compares preoperative and postoperative outcome on radiological evaluation, patient satisfaction, and clinical function.
*Results:* The study includes 15 patients. Radiological evaluation on Tibiofemoral Angle and Joint Space Ratio increases significantly. Patient satisfaction evaluation using SF12 significantly improve. Evaluation using KOOS and Oxford Knee Score also increase significantly.
*Conclusion:* PFO could become an alternative treatment for last stage knee osteoarthritis.

## 1. Introduction

Osteoarthritis (OA) of the knee joint, is a chronic progressive degenerative disease, accompanied by joint pain, joint stiffness, and deformity.[1] The prevalence of knee OA in Indonesia is also quite high at 15.5% and 12.7% in men and women respectively.[2] Factors leading to the progression of OA are mechanical, structural, genetic, and environmental factors.[3]

Total Knee Arthroplasty (TKA), which is a gold standard treatment for late-stage OA, and High Tibial Osteotomy (HTO) are commonly used procedures for OA of the knee. However, these procedures are relatively costly, complex and unsuitable either for young patients or patients with severe comorbidities that have the potential to cause complications or even death at the time and postoperatively.[4,5] HTO also has some disadvantages including the delay of patients undergoing full-weight bearings (FWB), increased risk of nonunion and delayed union, peroneal nerve paralysis and surgical wound infection (SSI).[6,7] Several other surgical procedures have been developed to prevent the progression of OA, including Proximal Osteotomy Fibula (PFO).

Zhang et al., in 2015 have succeeded in discovering PFO techniques as a new surgical technique to significantly relieve pain in a relatively short time to improve joint function, to allow postoperative ambulation conditions, and to restore joint space on the medial side of the knee. PFO also improves the alignment of lower limb alignment in some patients, especially in those with severe varus knees. Compared to TKA or HTO, PFO is a simple, safe, quick, and requires no additional implant insertion. Therefore, PFO could be an alternative procedure in most developing countries that are still constrained by funding and advanced instrumentation.[5]

Using a knee joint model with 3D finite element method, Maeyama et al. found that the contact of the lateral plateau pressure increased post-osteotomy of the fibula. This hypothesized that fibular osteotomy may reduce the pressure on the medial plateau so that pain in knee OA is reduced.[8] Prakash in 2015 also states a correlation between the proximal fibular osteotomy in cases of proximal fibular fracture with the result of a decrease in pain due to significant OA.[9] This finding is also supported by a study by Yang et al. in which long-term pain reduction is accompanied by changes in radiological features.

Based on the existing data, this study was conducted to determine the effectiveness of PFO procedures on the outcome of high-grade OA patients. Simple proximal fibula osteotomy (PFO) is expected to be an alternative solution for knee OA patients who can not undergo HTO or TKR surgery for various reasons.

## 2. Methods

This study was an observational analytic with prospective form, which was evaluated on samples of patients with radiological OA of the

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knee who would be compared with the clinical appearance of the patient. Sampling was done in total sampling to the research population of knee OA stage 4 varus type who performed PFO at one of the hospitals in Surabaya in the period July 2017 to December 2017.

Inclusion criteria include: all patients who performed PFO within the period from July 2017 to December 2017; patients with complete medical record data on identity, physical examination results, and postoperative scores may be performed for the function of the knee; and knee OA patients with a classification of stage 4 varus type who were unfit for TKA or HTO due to severe comorbidity. Exclusion criteria include patients who refused treatment and could not do the clinical evaluation. Criteria for drop out are patients who do not control and refuse to be evaluated.

Stages of preparation of research by performing complete patient data collection according to inclusion criteria, then the patient was called to the outpatient clinic or visit the patient directly with a home visit to evaluate clinically and assess SF12, KOOS, and Oxford Knee Score. Data of examination and counting result are grouped, presented in tabulation form, and analyzed descriptively. For inferential analysis using SPSS 23 program. The analytic statistics in this study used paired *t*-test for femorotibial angle outcomes and Joint Space Ratio on radiological evaluation, and SF12, KOOS, and Oxford Knee Score scores on patient satisfaction evaluation and clinical knee functionality (see Figs. 1 and 2).

## 3. Results

There were 15 patients with knee osteoarthritis degree 4 varus type performed PFO action from July 2017 to December 2017. We obtained 4 men patients (26.7%) and 11 women patients (73.3%) with an average age of 61.47 ± 8.34 years.

The mean measurement of preoperative tibiofemoral angle of 181.28° ± 1.88° and Joint Space Ratio (distance medial space (mm)/ lateral space (mm)) of 0.40 ± 0.02. The postoperative rate of 177.33° ± 2.06° and Joint Space Ratio of 0.57 ± 0.04.

The average preoperative SF12 score of 23.20 ± 1.74. KOOS calculation results are divided into 5 scores, namely: KOOS Pain score, KOOS Symptom score, KOOS ADL score, KOOS Sports score, and KOOS QOL score. The mean score of preoperative POS score was 39.98 ± 2.60; KOOS Symptom preoperative score of 40.91 ± 3.55, KOOS ADL preoperative score of 47.64 ± 2.58, KOOS Sport preoperative score of 33.36 ± 2.32, and KOOS QOL preoperative score of 38.81 ± 1.20. The mean score of the Oxford Knee Score Preoperative Questionnaire was 25.66 ± 4.18.


**Fig. 2.** Pre and postoperative comparison PFO knee results taken from one of the patients sample, female 63 years old.

The mean postoperative SF12 score was 38.06 ± 3.51. Calculation results average score of postoperative POS scores was 89.24 ± 1.35; KOOS Symptom postoperative score of 86.44 ± 1.41, KOOS ADL postoperative score of 82.28 ± 1.07, KOOS Sport postoperative score of 85.36 ± 0.88, and KOOS QOL postoperative score of 87.93 ± 0.80. The mean score of the Oxford Knee Score postoperative Questionnaire was 36.80 ± 3.00 (see Table 1).

## 4. Discussion

Knee osteoarthritis is one of the joint disorders that often occur and cause severe pain that leads to impaired mobility. Total Knee Arthroplasty (TKA) is an effective therapy in reducing pain and improves knee function in patients with end-stage osteoarthritis. However, TKA is an expensive and complex procedure and some patients require multiple revisions.[10]

In addition, there is another procedure called High Tibial Osteotomy (HTO). This procedure is a surgical treatment option for young patients with osteoarthritis in the medial compartment part of the knee.[11] Lack of this procedure is a long time before patients undergo full weight bearing rehabilitation and risk for non-union and delayed union, peroneal nerve paralysis, and wound infections.[12]

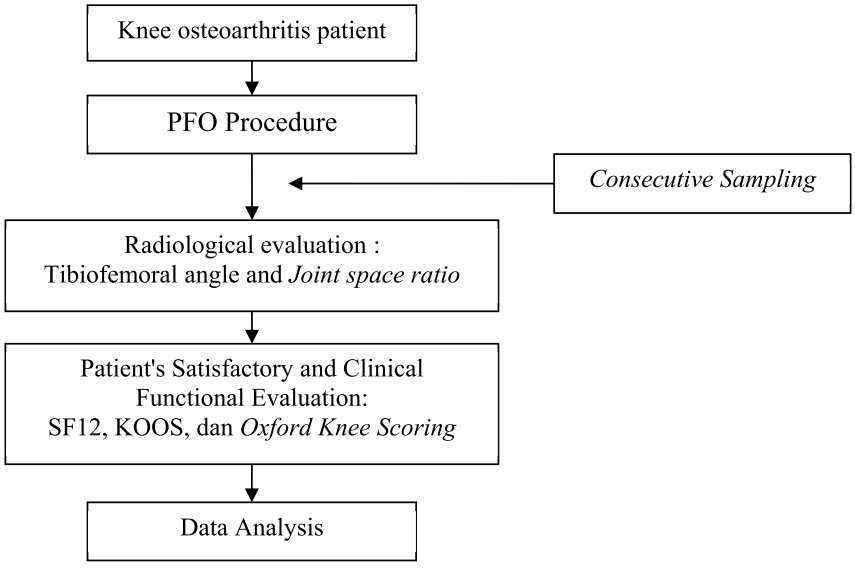


**Fig. 1.** Research scheme.

**Table 1**
Frequency distribution of Proximal Fibular Osteotomy patient characteristics.

| Patient Characteristics | Total | |
|---|---|---|
| Sex | | |
| Male | 4 (26,7%) | |
| Female | 11 (73,3%) | |
| **Age (yaers)** | 61,47 ± 8,34 | |
| **Examination** | **Preoperative (mean ± sd)** | **Postoperative (mean ± sd)** |
| Tibiofemoral Angle | 181,28° ± 1,88° | 177,33° ± 2,06° |
| *Joint Space Ratio* | 0,40 ± 0,02 | 0,57 ± 0,04 |
| SF12 *Daily Living Score* | 23,20 ± 1,74 | 38,06 ± 3,51 |
| KOOS *Pain Score* | 39,98 ± 2,60 | 89,24 ± 1,35 |
| KOOS *Symptom Score* | 40,91 ± 3,55 | 86,44 ± 1,41 |
| KOOS *ADL Score* | 47,64 ± 2,58 | 82,28 ± 1,07 |
| KOOS *Sport Score* | 33,36 ± 2,32 | 85,36 ± 0,88 |
| KOOS *QOL Score* | 38,81 ± 1,20 | 87,93 ± 0,80 |
| *Oxford Knee Score* | 25,66 ± 4,18 | 36,80 ± 3,00 |

Proximal Fibular Osteotomy (PFO) becomes the new choice of surgical procedure to reduce pain and improve joint function in patients with knee osteoarthritis as reported by Zhang et al. (2015). The most interesting is this procedure increases pain reduction in the medial part and increases the medial joint space.[13]

Bone mass decreases as part of the normal aging process.[13] Variations in the rate of bone mass composition are in joints used as load bearings, such as knees, hips, ankles, and spine. In the proximal tibia, lateral fibular support to the lateral tibial plateau usually leads to a non-uniform arrangement. The involved part is more severe in the medial plateau than in the lateral plateau. The slope of the tibial plateau arising from uniform deviations results in a transverse shear force, with the femoral condyle shifting medially during walking and exercise.[14] Furthermore, side-slip exacerbates the uniform arrangement of the tibial plateau, especially in the medial plateau. Thus, an increasing cycle of load distribution in the medial compartment and non uniform arrangement occurs. There is also evidence that tibiofemoral articular stress distribution is associated with knee OA occurrence.[5] Lateral support of the fibula to the tibial plateau is a key factor causing non-uniform arrangement of bilateral plateau and medial shift of the mechanical axis, resulting in degeneration and varus abnormalities of the knee joint.[15]

Zongyou et al. (2015) reported the use of proximal fibular osteotomy procedures as effective as high tibial osteotomy. From the above mechanism, our study looked at the tibiofemoral angle in patients undergoing proximal fibular osteotomy procedures.[15] We found in our patients there were significant differences in tibiofemoral angle before and after action ($p < 0.001$). We obtained improvement from the tibiofemoral angle in patients who performed proximal fibular osteotomy procedures. The mean of tibiofemoral angle of the patient decreases significantly so that the varus deformity is reduced. This is in line with the results of a study reported by Zongyou et al. (2015) at the patient's follow-up there was a significant decrease after proximal fibular osteotomy procedure.[15]

The radiological evaluation performed in addition to the tibiofemoral angle is the measurement of the joint space ratio to observe the narrowing of the joint gap. In our study, we found a statistically significant increase in joint space ratio in patients who had performed proximal fibular osteotomy ($p < 0.001$) procedures. Zongyou et al. reported that the ratio of increased joint space improved significantly statistically.[15] The improved radiological evaluation results will provide a good clinical evaluation because of the structural improvements of the deformity will decrease the pain of the patient's knee. Nevertheless, the proximal fibular osteotomy fixation mechanism cannot yet be fully explained. One theory holds that the improvement of the joint space and the tibiofemoral angle occurs because the fibula that serves as the support of the lateral part is removed. The fibula that causes varus genus in this case has a role to support one-sixth of body weight. Proximal procedure of fibular osteotomy re-stabilizes or distributes the load to the lateral and medial portions of the tibial plateau after surgery.[14]

Structural improvements achieved after the PFO are highly likely to enable functional improvement of the patient's knee. In our study, we looked at the results of clinical evaluation for the level of daily satisfaction of patient using SF-12 Daily Living Score. There was a statistically significant difference in the value of SF-12 Daily Living Score in patients after proximal fibular osteotomy ($p \leq 0.001$). There is an increase in the value of SF12 Daily Living Score, which indicates an increase in patient satisfaction with improved knee pain.

We observed also from the patient's knee function by evaluating the value of KOOS and Oxford Knee Score. There was an increase in knee function according to re-evaluation using the KOOS score in osteoarthritis patients who had undergone surgery. We found a statistically significant difference in the KOOS five score: KOOS Pain score, KOOS Symptom score, KOOS ADL score, KOOS Sports score, and KOOS QOL score in patients after proximal fibular osteotomy ($p \leq 0.001$).

To provide further confirmation we evaluate using Oxford Knee Score. Knee function in patients increases according to the Oxford Knee Score assessment after this procedure is performed. There was a statistically significant difference in the value of Oxford Knee Score in patients who had performed proximal fibular osteotomy procedure ($p \leq 0.001$). Patients can undergo better knee function than before surgery.

From our research, we can see that there is a correlation between the improvement of the structural knee joint with the patient's knee function in accordance with the theory. As the patient's knee function improves, patient satisfaction with daily life increases.

This study shows that proximal fibular osteotomy is a simple, safe, quick and affordable surgical procedure to reduce pain in the knee of end-stage osteoarthritis patients. In accordance with the previous article, the procedure of proximal fibular osteotomy can be used as an alternative to total knee replacement and high tibial osteotomy procedures. In addition, patients can still undergo a total knee replacement if needed. However, there are some shortcomings from this study in the form of a poor sample, the absence of comorbid control of the patient, and the absence of complete information on the patient's initial condition. This may be a reference for further research and requires experimental or prospective research for proximal fibular osteotomy procedures.

The proximal fibular osteotomy technique can be an alternative treatment option in patients with late-stage osteoarthritis. This is evident from the improvement of the 4 assessment parameters, namely: tibia-femoral angle after PFO is smaller than before the procedure, thereby reducing the varus deformity; Joint space ratio after PFO is greater than before the procedure, so that the medial joint cleft widened; increasing patient subjective score on SF 12 Daily Living Score; as well as increased functional scores of patients using KOOS and Oxford Knee Score. More studies are needed to further strengthen existing findings, including using larger sample quantities, and by randomized double-blind controlled trial or prospective research to reduce biases and errors in the study.

## Conflicts of interest

The authors declare no conflict of interest in this study.

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None.

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